Engineering Physics Lab Report 5

Experiment 5: Acceleration of free fall by means of the simple pendulum

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Objective 3

1. To show how the time of oscillation of pendulum depends on the length of cord
2. To determine the gravity acceleration constant

Learning outcome

Upon the completion of the experiment, I will be able to find the relation between periodic times of oscillation to length of cord and determine gravity acceleration constant from experiment.

Apparatus

Pendulum bob (e.g. a metal sphere with a hook attached, or with a hole bored through its center), string, stop-watch, meter scale, stand and clamp

Procedure 4

1. Tie a 30 cm length of the cotton to the pendulum bob and suspend the cotton from the jaws of an improvised vice, such as two metal plates held in a clamp
2. Place a piece of paper with a vertical mark on it behind the pendulum so that when the latter is at rest it hides the vertical mark from an observer standing in front of the pendulum
3. Measure the L of the cotton from the point of suspension to the point of attachment to the bob
4. Set the pendulum bob swinging through a small arc of about 10°. With a stop-watch measure the time for 20 complete oscillations, setting the watch going when the pendulum passes the vertical mark and stopping it 20 complete oscillations later when it passes the vertical mark and stopping 20 complete oscillations later when it passes the mark in the same direction. Repeat the timing and record both times.
5. Shorten the length of the pendulum by successive amounts of about 5cm by pulling the cotton through the vice and for each new length take two observations of the time for 20 oscillations.
6. Record down the reading and tabulated the result into the table below.

Results

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Length of pendulum (cm) (m)		Times for 20 oscillations			Time for 1 oscillation (periodic time) (sec)	T^2/s^2
		t_1	t_2	t_3		
30	0.3	22.49	21.79	22.14	1.107	1.23
25	0.25	20.09	20.04	20.064	1.002	1.004
20	0.2	18.08	18.74	18.38	0.919	0.8
15	0.15	15.42	15.76	15.59	0.7795	0.6
10	0.1	12.59	12.77	12.68	0.634	0.36
5	0.05	8.74	9.08	8.91	0.4	0.16

Experimental Details

1. When counting the oscillations remember to say “nought” when the stop-watch is started, for if you start “one” and stop and “fifty”, only 49 oscillations have been timed.
2. Be careful to count complete oscillations and not swings which are only half a complete oscillation.
3. Do not reduce the length of the pendulum below 50 cm as the experiment becomes increasingly in accurate the shorter the length of the pendulum.
4. Should the oscillations of pendulum bob become elliptical at any time the timing should be rejected. The pendulum stopped and set oscillation again and a new timing made.

Theory and Calculations

The periodic time T of a simple pendulum l is given by

$$T=2\pi\sqrt{\frac{l}{g}}$$

Where g is the acceleration of free fall.

Since in this experiment

$$l = L+\varepsilon$$

Where ε is the extra constant length to the center of gravity of the bob,

$$T=2\pi\sqrt{\frac{L+\varepsilon}{g}}$$

And

$$T^2=\frac{4\pi^2}{g}.L+\frac{4\pi^2}{g}.\varepsilon$$

From which it is seen that the graph of T^2 against L k will be a straight line whose slope m, measured from two convenient and well separated pints P and Q on the line, is numerically equal to $\frac{4\pi^2}{g}$

Thus $\quad m = \frac{4\pi^2}{g} \quad , \quad g = \frac{4\pi^2}{m}$